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THE DYNAMICS OF REGIONS MOVING TOWARD ENERGY SELF-SUFFICIENCY: EXAMPLES OF 100% RENEWABLE ENERGY INITIATIVES FROM DIFFERENT REGIONS AROUND THE WORLD

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Abstract

Aiming to resolve global warming, renewable energy is developing rapidly at the global level. Renewable energy has many contacts with local regions based on its decentralized and low energy density characteristics. Thus, the attitudes of local citizens and local acceptance are significantly affected by the sustainability of renewable energy projects. As another new movement, international frameworks including the Paris Agreement and UN Sustainable Development Goals differ from the previous approach, which did not set numerous indicators, but required that each government drew their visions and goals. Each national/regional government had to establish and achieve targets autonomously.

This research focused on the 100% renewable energy initiatives to consider the sustainable energy society. The purpose of the paper is to 1) grasp the holistic trend of the 100% renewable energy initiatives worldwide and 2) dissect case studies and details of the targets, its motivation, civic involvement, and local/social background. A series of data related to the 100% renewable energy targets was collected through the research network of the 100% renewable campaign. Moreover, interviews and questionnaires in Osnabrück, Vancouver, San Francisco, and Frederikshavn were conducted at the international conference in Kassel, Germany. Interviews and field visits to Fukushima prefecture were conducted to compare the international situation with the domestic situation in Japan.

The results indicated that 78 countries, regions, islands, and cities had set 100% renewable goals by the beginning of December 2015. The main sectors of the targets are electricity, transport, and heating/cooling; however, the combination of targets is diverse. The results also imply that dozens of communities had formulated a 100% renewable energy target by comprehensively reevaluating the energy system while respecting their historical backgrounds and local conditions. Even in metropolitan

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areas, the possibility of setting a 100% renewable energy policy target by combining climate change countermeasures, regional development, and urban planning was demonstrated.

Furthermore, it is important to understand that setting the target is the first step, and municipalities must implement the project in medium to long-term strategies. Therefore, observing and monitoring the project through public participation from diverse sectors, evaluating projects from different angles, and efforts to cooperate with citizens should be emphasized in the implementation stage.

In conclusion, the regional cases discussed in this research suggest the possibility of setting and achieving 100% renewable energy targets by combining resources and projects. In addition, many options as solutions to improve energy self-sufficiency exist. For the prospects of a Japanese energy strategy, it is expected that a high commitment to renewable energy will be set through national decision in addition to the initiatives of citizens, as well as regional and private sector initiatives.

Key words: case studies, renewable energy, energy self-sufficiency,
energy policy analysis

1. Introduction

Renewable energy[1)] is rapidly being developed at the global level, with the aim of resolving climate change. Due to its decentralized and low energy density characteristics and the fact that, compared with other energy sources, many areas can function as energy supply sites, renewable energy-related power generation facilities have been introduced all over the world. Meanwhile, since renewable energy has many points of contact with local communities, it is thought that, when it comes to business operations, the relationship with the local community affects the sustainability of the energy business.

With policies to promote renewable energy having been introduced en masse after the Great East Japan Earthquake, in recent years Japan has seen an especially rapid increase in the introduction of renewable energy, with the bulk of this being in the form of photovoltaic power generation. However, with rapid progress in this area, conflicts often arise between communities and renewable energy facilities such as wind farms and large-scale solar power plants (Azechi & Nishikizawa 2014, Institute for Sustainable Energy Policies 2016). In addition to resolving regional differences over renewable energy development in Japan, there is also a call to strategically utilize the unique characteristics and unused resources of the region, while respecting the views of the local community. As we mentioned at the beginning of this paper,

1) Energy that utilizes sustainable renewable resources such as solar and wind power generation (renewable energy) rather than exhaustible resources such as fossil fuel is called “renewable energy,” or “new energy” depending on the context. In this paper, the terms used by each organization are cited as is, in keeping with the context of original sources.

given the fact that renewable energy is a major solution to the climate change problem, the end game when it comes to sustainable energy systems is thought to be to construct a "100% renewable energy" society. Therefore, in this research, to describe the outlook for such a society, we first focused on the "100% renewable energy policies" that are to form its basis. Reviewing renewable energy policies, there are many comprehensive statistical materials and reports dealing with good practices (Teranishi, Ishida, & Yamashita 2014; Morotomi 2015; Ueda & Yamaga 2017), while efforts and research focusing on 100% renewable energy are also evident (Chiba University Kurasaka Laboratory Sustainable Zone; deENet; International Energy Agency (IEA); Renewable Energy Network for the 21st Century (REN21); World Wildlife Fund (WWF); Greenpeace). However, as this is a challenging subject, there have still not been any discussions that comprehensively cover and analyze 100% renewable energy policies worldwide and the status of such efforts. Therefore, in this research, it is our aim to consolidate the 100% renewable energy efforts being made in each region to the extent possible, and to describe their main tendencies. Moreover, looking at several examples from overseas, we emphasize qualitative information such as the context of regional communities that form the backdrop to various objectives and initiatives and, by comparing these with examples from Japan, we clarify the issues related to the realization of a 100% renewable energy society from a regional perspective, as well as the prospects for realizing such a society. Based on this process, we seek to plot out the future development of 100% renewable energy initiatives in Japan.

The lead author has been conducting research on the social issues that accompany renewable energy development, mainly in the outlying islands of Japan, for about six years. Moreover, she also worked as a visiting researcher for six months as part of the Global 100% Renewable Energy Campaign (Figure 1)[2] led by a German NGO, the World Future Council (WFC). While

Figure 1. 100% Renewable energy area map published on the 100% Renewable energy World Campaign web page (April 2016)

[2] The goals of various entities such as national, regional, state, county, and municipal governments, civil campaigns, and enterprise energy procurement goals, and the like may be related to 100% renewable energy-related initiatives. In this study, we deal with local governments.

carrying out joint research, she was also blessed with the opportunity to work on state-of-the-art renewable energy research with experienced researchers at relevant research institutes in Japan. In the present research, we will review the latest renewable energy policies and the circumstances surrounding these, while making maximum use of relevant research networks and resources. Specifically, by analyzing examples of each region from a 100% renewable energy policy viewpoint, we seek to clarify issues related to regional implementation of renewable energy, while also highlighting relationships with the international community to deal with such matters as climate change and issues related to future energy policy approaches.

2. Trends in Regionally-Based 100% Renewable energy Initiatives Around the World

As of 2016, 19.3% of worldwide energy consumption was supplied by renewable energy, while 24.5% of generated power was in the form of renewable energy (REN21 2017). Reflecting this state of affairs, the presence of renewable energy was emphasized in the annual report by the International Energy Agency (IEA) in 2016, with accounts and analysis of renewable energy accounting for a larger portion of the paper than in years past (IEA 2017). As summarized in the previous report (Matsumura & Miyoshi 2017) it is pointed out here that renewable energy and energy efficiency will come to form major trends in energy development in the future.

Meanwhile, after the Paris Agreement adopted at the conclusion of the Framework Convention on Climate Change (COP 21) in December 2015, the international community paid increasing attention to countermeasures to climate change, with energy conversion efforts accelerated. The scope of these initiatives not only involves promoting power generation and energy efficiency by using renewable energy but also leads to new policies and regulations. In the transportation field, specifically, bans on the sale of diesel vehicles over the medium- to long-term are being studied in such countries and regions as the Netherlands, the UK, the EU, and China, with dramatic changes evident over the last year.[3)] As previously mentioned, given that renewable energy is diversified, relevance to the community, environmental impacts, and other areas have been evaluated. In other words, while rethinking renewable energy as a social entity, it has become apparent that we need to reevaluate this in the context of each community (Maruyama 2014). Moreover, regional societies are not in positions to simply passively accept development; they are also entities unto themselves, meaning that attention is being paid to regional initiatives and consensus building. An example of this is the 1st World Community Power Conference,

3) According to a Nihon Keizai Shimbun article dated July 27, 2017, in addition to the banning of the production and sales of gasoline and diesel vehicles in the Netherlands and Norway by 2025, the sale of gasoline and diesel vehicles is to be banned in Germany beginning in 2030 and in France and the UK by 2040. According to a Nihon Keizai Shimbun article dated September 11, 2017, China is committed to the production of new energy vehicles, such as a certain number of EVs. In the medium to long term, they will consider banning production and sales of gasoline and diesel vehicles, although the specific time frame has not yet been decided.

where over 600 participants from more than 30 countries gathered in November of 2016.[4] Meanwhile, research involving analysis of attitudes toward renewable energy in local communities is gaining attention, and there continues to be a wealth of studies concerning the "public acceptance" mainly of wind power, which has been introduced and analyzed ad nauseam overseas (IEA Wind Task 28 2012). For example, Schweizer-Ries (2008) classified regional attitudes of acceptance toward renewable energy into four quadrants and six categories using two positive-negative, active-passive axes. In addition, local citizens and residents often have diverse attitudes of acceptance, making it necessary to grasp differences in recognition when considering various cases, as equitable procedures are required to develop renewable energy in a harmonious manner. Motosu (2016) pointed out that so-called "voiceless" citizens who do not present an opinion on questionnaire surveys targeting citizens residing in the vicinity of wind power facilities are not necessarily in favor of renewable energy, and that therefore it is critical to pay attention to citizens who do not voice their opinions. Furthermore, accompanying the active development of geothermal power plants, in addition to wind power generation, it is apparent that efforts have been made to reevaluate the pluses and minuses of each renewable energy source, given the contexts of local communities, and discuss these repeatedly with residents (Maruyama 2016). In addition, even though the technology is the same, depending on the history of the use of renewable energy and the cultural values and industries of the region, one can learn from the unanticipated rejection of a geothermal power plant in Hachijojima (Matsumura & Miyoshi 2016). In other words, because regions differ socially and culturally, it is apparent that we need to promote policies to improve the relationship between renewable energy businesses and local society, and, in creating policies to promote the introduction of more renewable energy, proceed with different approaches for each country, region, or local government with differing economic standards, resources, and industries. Of course, the establishment of statistical data by such international organizations as REN21 and the understanding of trends in this area is important but, from the viewpoint of placing more emphasis on the region, it is also increasingly imperative to consider factors for promoting energy policies. In addition to renewable energy, policy trends that emphasize the independence of the region can be observed using other international frameworks. For example, with the sustainable development targets presented to the United Nations in 2015, instead of requiring each country to establish and attain obligatory targets, the setting of numerical targets was for the most part transferred to the region. With sustainable development targets, in addition to setting targets, specific numerical indicators, measurements, monitoring, and the setting of target

[4] We derived the number of participants from the Aizu Electric Power Company web page (http://aipower.co.jp/archives/1166).

values are also left to each country/region[5]. Furthermore, with the Paris Agreement presented and adopted at COP 21 in 2015, it is felt that not setting concrete numerical targets contributed to the formation of the agreement on climate change. In other words, as society becomes more diverse and complex, to fulfill the realization of a desirable world as presented by the international community, there is a need for each country and region to reinterpret its future image in the context of the regional unit and place themselves in their own policies and initiatives, while respecting the social context. Therefore, each country or region must first analyze its current situation and characteristics in detail, and set policy goals based on this. Also, at the policy implementation stage, it is critical to collaborate with a diverse range of stakeholders and objectively evaluate them using common international standards, as active participation by each country/region at levels much higher than in the past is considered important. Therefore, we will concretely analyze the following, even as we reconfirm that the importance of regionally-based policy initiatives—particularly regionally-based 100% renewable energy policies—is increasing.

3. Survey and Analysis Methods

3.1. Cases studies of international regions

With the cooperation of researchers and local government officials from the Global Campaign on 100% Renewable Energy, from April through November 2015, the authors collected data using a questionnaire. Furthermore, with respect to energy sectors for which the various regions have established 100% renewable energy policies, business plans including budget projections, collaboration with local communities and regional companies, and so on, we also created nine specific items and question groups (Figure 2) and interviewed participants from four regions at the international conference site[6] (Table 1).

3.2. Case studies in Japan

With respect to cases in Japan, in addition to information gathered through the research network in 2015 during research activities at the WFC, the authors utilized participatory observations from field surveys carried out in Fukushima Prefecture in 2016 and 2017 and the results of interviews with local government officials and energy companies (Table 2).

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[5] In the summer of 2017, the lead author participated in the Japan-German Young Leaders Forum, where she discussed the sustainable development goals of the United Nations with Japanese and German experts and young executive candidates. At the forum, one of the issues that became the focus was the effectiveness of SDGs, the role of the private sector, and the role of citizens.

[6] With respect to the Kassel International Dialogue on 100% Renewable Energy Congress, Kassel, Germany, November 10–11, 2015, the report can be accessed by clicking on the following link: https://go100re.net/wp-content/uploads/2014/01/KasselFinalreport_160303.pdf

1) Establishing plans and targets related to 100% renewable energy
   - Long-term plans including renewable energy that have been executed so far
   - Are the objectives, reach points, and milestones in the plan a blueprint with detailed steps, or a more conceptual long-term vision?
2) Integrating renewable energy with other sectors
   - How are renewable energy and electricity, cool/heat and transportation presented?
   - The presence or absence of cooperation with public services such as water supply, public health, and public transport
3) The role of municipalities
   - The appointment of staff, offices, or departments that the community created specifically to realize long-term 100% renewable energy conversion
   - The roles and responsibilities of municipalities
4) Results and achievements
   - Concrete results and achievements to date
   - Current renewable energy capacity
   - The ratio of renewable energy with respect to energy consumption
   - Percentage of renewable energy supplied in the heat supply and transportation energy sectors
   - Capacity per unit of solar power generation
   - Long-term planning and milestones and degree to which these are achieved
5) Newly introduced technology and degree of change
   - Were technological changes such as energy production, supply-distribution, demand management infrastructure created? (Examples: smart grid technology, connections with renewable energy heat supply and electric vehicle charging infrastructure, heating of community-scale solar power plants and public facilities)
6) Finance and business models
   - Innovative business and finance models developed for energy production and energy service energy demand (Examples: Promotional measures for cooperatives and energy production, community ownership, cloud funding, micro utilities, energy service providers, regionally-certified green power retailing, demand management schemes, energy efficiency, investment models)
7) Policy making and its effects
   - Policies introduced to provide instructions at the local level for 100% renewable energy What was the initial impact on policy?
8) Community participation and social networks
   - To make activities, plan formulation, and process execution more participatory and comprehensive, social networks and structures were created in the community: individuals who have driven the creation of social networks and structures; and founded organizations, educational programs and education centers
9) Leadership and historical background
   - History of the development of the community with respect to long-term energy goals, plans, and commitments to 100% renewable energy.
   - Certain individuals who are supporters or sought after.
   - Participation in the business sector. Did a mayor or council play an important role?
   - Requests to realize regionally oriented goals and local autonomy.

Figure 2. Question Categories and Subordinate Question Groups (Global Campaign on 100% Renewable Energy Global Progress Panel (GPP)[7] report questionnaire translated by authors)

[7] The GPP (GLOBAL PROGRESS PANEL) is a project being undertaken by the Global Campaign on 100% Renewable Energy that involves the periodic collection and compiling in report form of qualitative information from different regions around the world.

TABLE 1.
Overview of the Survey

Survey date	December 10–11, 2015
Survey method	Structured interviews
Place	"Kassel International Dialogue on 100% Renewable Energy" conference in Kassel, Germany
Interviews	Staff of Osnabrück (Germany) Municipal Environment and Climate Change Department; city officials from San Francisco (US); Environmental Department staff from Vancouver (Canada); the mayor of Frederikshavn (Denmark)

TABLE 2.
Overview of the Survey

Survey date	November 6, 2016	January 16, 2017
Survey method	Participatory observations, unstructured interviews	Participatory observations, unstructured interviews
Place	Tsuchiyu Hotspring, Fukushima City, Fukushima Prefecture	Aizu Electric Power Company, Kitakata City, Fukushima Prefecture
Interviews	Representatives of Genkiup Tsuchiyu Binary Electric	Representatives of Aizu Electric Power Company, Iitate Electric Power Company (Fukushima City, Fukushima Prefecture), Iitate Village Chamber of Commerce and Industry personnel

4. World Trends in 100% Renewable energy Initiatives

The results of the survey will be divided into overall trends and cases by region, and these will be discussed sequentially.

4.1. Overall Trends in 100% Renewable energy Districts

First, let's briefly summarize overall trends when it comes to 100% renewable energy initiatives. As of December 1, 2015[8], the 78 areas indicated in Table 3 had introduced 100% renewable energy campaigns.

Most of these regional cases are from Europe; not even a single case from South America was noted as of 2015[9]. It is thought that the fact that the WFC, which serves as the secretariat of the world campaign, is in Germany was a factor in this regard[10]. In addition, it is also thought that

[8] Seventy-eight cases had been introduced as of November 2015, when the lead author was working at WFC as a visiting researcher.
[9] As of September 2017, Venezuela, Bonaire, and Aruba had been introduced in the South American continent.
[10] Presently, the World Wind Energy Association, which is based in Bonne, Germany, serves as the secretariat.

Table 3.
Number of Cases [of Introduction of 100% Renewable energy Campaigns] categorized by Continent

Continent	Number of regions
Africa	3
Asia	6
Europe	51
North America	11
South America	0
Oceania	7

Created by the authors based on the WFC: Global 100% Renewable Campaign website

Table 4.
Classification of 100% Renewable energy Areas for Each Energy Sector Included in the Targets

Sector type included in the target	Number of regions
Electricity	25
Electricity, heating/cooling	22
Electricity, transportation	6
Electricity, heating/cooling, transportation	24
Transportation	1

Created by the authors based on the WFC: Global 100% Renewable Campaign website

it is necessary to further investigate regions other than Europe, i.e., Asia, Oceania, and Africa.

Next, we divided the 100% renewable energy targets into three sectors—electricity, heating/cooling, and transportation—for analysis (Table 4). As you can see, the greatest number of regions are those with target settings for electricity only. However, there are almost as many regions with target settings for all sectors—electricity, heating/cooling and transportation—as regions with target settings for electricity and heating/cooling. As such, while 100% renewable energy targets are centered on electricity, we can see that targets are growing to include sectors with fewer solutions such as heating/cooling and transportation. In addition, each target setting includes a government policy framework that includes medium- to long-term plans (Examples: Cape Verde, Fukushima Prefecture, South Korea's Jeju Island, Indonesia's Zumba Island, City of Frederikshavn in Denmark), as well as speeches such as the 100% renewable energy declaration[11)].

[11)] Because the objective of the Global Campaign on 100% Renewable Energy is to provide enlightenment with respect to the 100% Renewable energy Initiative, no policy initiative has been presented, but this also includes regions that have achieved 100% renewable energy.

4.2. Examples of 100% Renewable energy Policies in Local Governments Around the World

In the section that follows, we will analyze the efforts of various regions based on the results of local observations and interview surveys.

4.2.1. Osnabrück (Germany)

Osnabrück is a German city with a population of 168,000 people (as of August 2017) (Table 5).

Osnabrück has decided to supply electricity using 100% renewable energy by 2030, and has also set targets for energy efficiency. As mentioned previously, the city established 100% renewable energy supply targets for the three sectors of electricity, heating/cooling, and transportation. However, due to the fact that Osnabrück covers a wide area, the amount of renewable energy available within the city itself is limited. As such, in cooperation with the broader Osnabrück district, the city is promoting conversion to renewable energy (Matsumura & Miyoshi 2017). Osnabrück city operates more than 50 programs promoting conversion to renewable energy.

For example, to promote household energy conservation such as the installation of solar panels and thermal insulation amongst the citizenry, using aerial photographs, the city published a solar map on its website to help visualize the photovoltaic power generation and energy loss of each household. Given that, due to past initiatives, the effectiveness of these efforts has been highlighted (Matsumura & Miyoshi 2017), this "solar maps" are increasingly being introduced in other areas, including Ueda City, Nagano Prefecture, which has exchanges with the city[13]. The latest website updated in 2017 indicates estimated solar power generation and specifications that highlight the production potential of hot water that can be used for washing and cleaning. Bicycle lanes are also being introduced to the streets of Osnabrück and big strides in energy conversion are also taking place in terms of transportation (Figure 3).

To date, 485 MWh of renewable energy have been introduced in the city of Osnabrück with another 1098.9 MWh introduced in the surrounding Osnabrück district (Table 5). Because the

Table 5.
Osnabrück's 100% Renewable energy Scheme

	Population (persons) (Sept. 2017)	Annual energy demand (sector)	Target value (target year)	Results
Osnabrück City	168,000	904,396 MWh (Electricity)	100% (2030)	49 MWh (Electricity)
Osnabrück District (resource utilization)	358,000	184,920 MWh (Electricity)		1,099 MWh (Electricity)

Created by the authors based on documents from the 2017 Local Renewables Conference[12]

[12] This is based on content presented at the International Renewable Energy Conference held in Nagano City in September 2017. More information can be found on the following web page. (http://local-renewables-conference.org/fileadmin/repository/LR_Nagano/PPTs/LR2017_2A_Gerdts.pdf)

[13] Based on a report by Ueda City, Nagano Prefecture during the 2017 Local Renewables Conference held in Nagano Prefecture in September 2017. More about this international conference can be found at the following link.

Figure 3. Bicycle lane in the City of Osnabrück
(Photo taken February 28, 2017 by the author)

flow rate in the district exceeds that of the city's demand for electricity, the City of Osnabrück is recognized as a 100% renewable energy city. Future forecasts are for an acceleration of energy transformation measures not only for electricity but also for transportation and heating/cooling.

4.2.2. Frederikshavn (Denmark)

Located in the northern part of Jutland, Frederikshavn has a population of approximately 102,000 people. In 2014, it submitted a "Master Plan for Achieving Renewable Energy by 2030." With this plan, the goal is to strategically achieve 100% renewable energy in the electricity, heating/cooling, and transportation sectors (Table 6).

The city thus developed a master plan to achieve its 100% renewable energy targets by 2030. First, the city set out to increase the share of renewable energy provided by wind power to up to 51% by introducing publicly- and privately-owned wind power plants at 10 locations. To date, the proportion of renewable energy has remained at only 18%. In addition, due to its location in the northern part of Denmark, 21% of this is in the form of wind power and 45% is from biomass. Forming a backdrop to Frederikshavn's energy policy is Denmark's national renewable energy strategy. As a nation, Denmark has set a 100% renewable energy target for 2050. As a prelude to this, by 2030 it plans to eliminate coal from its raw materials for regional heating.

Table 6.
Frederikshavn's 100% Renewable energy Scheme

Population (persons)	Annual energy demand (sector)	Energy demand target value (target year)
102,717	2593.63 GWh (electricity, 2010)	n.d. (2030)

Created by the authors from the result of a questionnaire administered to the residents of Frederikshavn[14)]

[14)] Collected on a questionnaire at the time of the survey in 2015

Such calculated national policy is a major driving force for the development of 100% renewable energy policy in Frederikshavn. As a backdrop to local communities tied to the goal setting of Frederikshavn, there was a sense of crisis with respect to the decline of the regional economy, and the city also desired to improve current use. The main industries in Frederikshavn are shipbuilding and tourism. However, in recent years, the unemployment rate in Frederikshavn has stood at 6.6%, the second highest in Denmark, making activation of the regional economy an important issue. It is believed that the 100% renewable energy target will restore regional economic activity and lead to the lowering of fossil fuel price impacts on the regional economy.

4.2.3. San Francisco (US)

With a population of about 800,000 people, San Francisco is located on the west coast of the US. As a measure of the target of reducing greenhouse gas in the energy sector, in its "Climate Action Strategy," the City of San Francisco has set a target to produce electricity within the city using 100% renewable energy by 2020. This 100% renewable energy policy also involves setting goals for energy efficiency. Approximately 120 officials from the city's Environmental Department are involved in this effort. For example, areas where San Francisco's Environmental Department has the main responsibility include different small sections such as transportation, environmental civil engineering, energy, waste and the like, with the staff of each of these sections working in cooperation. In other words, target settings include not only initiatives targeting greenhouse gases but also measures for sewerage, public health, public transportation, and energy conservation over a broader area. Thus, under the catchphrase of climate change countermeasures, this target setting involves integrated content.

A distinctive feature of San Francisco is that, based on the $250,000 awarded by the Sydney Frank Foundation in 2010, the city is set to progress to 100% renewable energy by 2020. Moreover the city owns the largest hydropower station in San Francisco. This is a rare example of ownership of energy production facilities by local government and the management of these facilities by the city.

In order to achieve its goals, San Francisco is also focusing on energy conservation. Meanwhile the biggest impact of greenhouse gases is on the transportation sector; the city is attempting to tackle this over the long term by promoting electric vehicles (EV). Of course, being a prominent US city, San Francisco has limited natural resources, so plans are to also cooperate with neighboring areas in this regard.

TABLE 7.
San Francisco's 100% Renewable energy Scheme

Population (persons)	Annual energy demand (sector)	Energy demand target value (target year)
805,000	(Amount of greenhouse gases)	n.d. (2020)

Citation from San Francisco's "Climate Action Strategy"

Behind the scenes, the mayor has taken the initiative when it comes to these 100% renewable energy efforts. At the same time, when interviewed, staff of San Fransisco Department of the Environment explained that the past experience of San Francisco's citizens also played a part. Surrounded by the ocean, San Francisco has a very mild climate, but it has also historically experienced flooding due to this proximity to the ocean. This experience is tied to the motivation to evaluate the risk of climate change and reduce the greenhouse gases that are considered the cause of climate change. For this reason, a unique feature of San Francisco's efforts is the fact that, in addition to the policy objective of 100% renewable energy for electricity, within the climate change framework the city also sets goals for reducing waste, as well as halving the emissions of greenhouse gases from electricity, natural gas, and the transportation sector.

As of 2011 the city's energy mix consisted of 16% renewable energy other than hydroelectric power, 30% large-scale hydro power, 36% energy sources derived from fossil fuel, and 18% nuclear power[15].

4.2.4. Vancouver (Canada)

With a population of about 600,000, Vancouver is the most densely populated city in Canada and British Columbia's largest city. Vancouver has its sights set on establishing itself as a leading green city. In December 2015, a policy for realizing 100% renewable energy by 2050 was established in the three sectors of electricity, heating/cooling, and transportation. With the approval of the Vancouver City Council, the city has launched its 2015–2050 renewable energy strategy, with two overriding goals: 1) transforming all the energy used in Vancouver to renewable energy sources by 2050; and 2) reducing greenhouse gas emissions by at least 80% over 2007 levels by 2050. Moreover, these target values also include energy efficiency targets to lower the energy demand in the consumer/business and transportation sectors, with the bulk of consumer/business efforts aimed at buildings. In addition, when looking at the transportation system as a whole, while the installation of on-site power generation facilities continues to gain steam, projects from different fields such as transportation—including infrastructure maintenance—and electric power are continuing to be consolidated and operated within the city's urban plans, as can be seen in increased car-sharing. In addition, the city of Vancouver has introduced a carbon tax and is also working on the creation of economic incentives.

Meanwhile, in addition to top-down projects to encourage citizen discussion, officials in the Environmental/Climate Department are responsible for leading these efforts, while the city also plays a role in bottom-up efforts. In addition to incorporating citizen debates, the Department is also increasingly collaborating with experts. For example, serving as a consulting group to help in achieving goals, the Department invited transportation companies, groups working on environmental sustainability, and experts from the environmental planning, environmental engineering, and renewable energy fields to share in this effort, collaborating with them. In

[15] Collected on a questionnaire at the time of the survey in 2015

Table 8.
Vancouver's 100% Renewable Energy Scheme

Populate (persons)	Annual energy demand (sector)	Energy demand target value (sector target year)
603,500	59.3 million GJ (all sectors)	39.3 million GJ (all sectors 2050)
	45.1 million GJ (consumers/businesses)	28.3 million GJ (consumers/businesses 2050)
	14.2 million GJ (transportation)	11.0 million GJ (transportation 2050)

Created by the authors based on the results of a questionnaire survey administered to Vancouver city officials[16)]

addition to the consulting group, an adviser team consisting of external energy experts was also established. This team includes lawyers, environmental NGOs, segments of industry, citizen representatives, and other concerned parties. Under the leadership of the Mayor, who serves as its Chair, the group regularly monitors and manages the progress of energy conversion efforts from a multidirectional point of view.

These energy plans that are to continue until 2050 are treated as an extension of the "2020 Environmentally Friendly Urban Action Plan" created in 2011. In other words, Vancouver's long-standing efforts on this front serve as the foundation of these initiatives.

As a result of the city's efforts to date (Table 8), 31% of Vancouver's energy demand is met by renewable energy. A breakdown of this shows that 25% is large-scale hydroelectric power and 3% is biomass, with biofuel and solar making up 1% each[17)].

4.3. 100% Renewable energy Initiatives Around the World: Overview and Issues

As previously reported (Matsumura & Miyoshi 2017), international policy initiatives are undergoing radical change. Notably, the trend toward 100% renewable energy policy initiatives, electrification, and energy efficiency is rapidly gaining traction. Also in the planning for regional examples already covered, even when population, functions, and characteristics of cities differ, we can see that planning can be formulated by ensuring a diversity of options. For example, even global urban areas such as Vancouver and San Francisco have long-term 100% renewable energy policy objectives. Furthermore, in each region, as a backdrop to this, various motivations such as citizen committees, discussions, citizen initiatives, and foundations can also be seen. The 100% renewable energy policy tends to be interpreted as a top-down approach, but if we analyze the social context, it becomes evident that citizen input is being incorporated. It is thought that these citizen activities can serve as a foundation to support activities aimed at a long-term 100% renewable energy society. To ultimately realize a 100% renewable energy society, it is critical to implement medium- and long-term plans; setting targets is only the starting point in this endeavor. In other words, it is necessary to not only formulate a plan but also to regularly

[16)] Collected on a questionnaire at the time of the survey in 2015
[17)] Collected on a questionnaire at the time of the survey in 2015

review it, while considering the social landscape and trends. It is for this reason that, in Osnabrück, Vancouver, and San Francisco, monitoring was conducted by external committee members and observers, in cooperation with local communities. Given these local initiatives, it is evident that the establishment of a place to capture the opinions of various stakeholder opinions and the participation of citizens are considered to be vital to achieving long-term goals.

Meanwhile, the results of this survey have resulted in a number of new issues. Issues common to all regions included: 1) creating sustainable business models; 2) securing monetary resources to support policies; and 3) maintaining transmission lines and other infrastructure. With the creation of business models, especially, institutional differences have a big influence, and it can be difficult for the regions of various countries to replicate these. For example, the carbon tax that Vancouver is set to introduce would likely be difficult for core cities in other countries to implement. On the other hand, there were cases where solutions could be propagated by continuing information exchanges and networking efforts, such as the case where the solar mapping of Osnabrück City is to be adopted by Ueda City, Nagano Prefecture. In other words, it is thought that exchanges between cities will become important in the future.

5. Toward the Development of Renewable Energy Initiatives in Japan

In the previous chapter, we examined the impact of 100% renewable energy initiatives around the world and looked at cases overseas, examining the diversity and effectiveness of these policies. In this chapter, we will analyze the characteristics of initiatives being implemented in Japan as we seek to deepen analysis of fields where cooperation is possible with respect to 100% renewable energy initiatives, as a countermeasure to climate change.

5.1.1. Fukushima Prefecture

Agriculture plays an important role in Fukushima Prefecture, which has a population of about two million people. On March 11, 2011, a magnitude 9.0 earthquake struck the region, with serious damage resulting from the quake and ensuing tsunami. Local production for local consumption using renewable energy is cited as a pillar of regional revitalization. A goal in Fukushima Prefecture involves plans to have 100% renewable energy meet energy demands by 2040 (Table 9).

Table 9.
Fukushima Prefecture's 100% Renewable energy Scheme

Population (persons)	Annual energy demand (sector)	Energy demand target value (target year)
2,000,000	9,087,228 kJ (Primary energy demand)	8,219,734 kJ (Primary energy demand: Intermediate goal 2030) n.d. (Final goal 2040)

Created by the authors from "Local Action Plans for Renewable Energy Initiatives"

Fukushima Prefecture's goals are reliant upon the "Fukushima Prefecture Renewable Energy Implementation Vision (revised version)." This implementation vision was formulated in March 2011—the same month the Great East Japan Earthquake occurred—and was revised in 2012, when the 100% renewable energy targets were added. Furthermore, in December 2012, renewable energy was cited as an important part of restoration work in the "Fukushima Restoration Plan."

In addition, to achieve its renewable energy goals, in February 2013, the prefecture announced its "Local Action Plan for Renewable Energy Initiatives," with mid-term targets established for both the first period, which ran from 2012 to 2015, and the second period, which ran from 2015 to 2018.

Ishida (2016) consolidated the concrete results of efforts carried out by Fukushima Prefecture, as indicated below. The renewable energy ratio, which had been 21.9% in 2011, reached 26.6% three years after the plan was formulated, surpassing the mid-term target for 2015 of 25%. The second phase of the action plan will continue until 2018, and will be expanded to mainly include sunlight and biomass. As for wind power generation, development projects involving offshore as well as onshore wind power are also being launched. Although geothermal utilization is limited, cutting-edge approaches are being carried out in this area. With the considerable interest following the Great East Japan Earthquake, Fukushima Prefecture has been studied from different angles regarding its development of renewable energy and the influence this has had on local communities. For example, Yamaguchi (2014) divided Fukushima Prefecture's renewable energy initiatives into roughly two types for analysis. The first involved improvements in research bases. The Fukushima Renewable Energy Laboratory, a new base for the Industrial Research Institute that is dedicated to offshore wind power and next-generation non-technical development, was established in Koriyama City, Fukushima Prefecture. The second involves policies to promote multilayered renewable energy. In addition to the fixed price purchase system of renewable energy that the country is undertaking, there are also support projects to promote the introduction of renewable energy equipment, in support of recovery and reconstruction work, and projects to promote the introduction of citizen exchange facilities in Fukushima Prefecture, as well as a variety of other efforts. Based on the results of the questionnaire survey, Shirai (2016) concluded that citizens expected renewable energy to be used to structurally restore the region and that the energy business, which is based mainly in the area, had increased. Mitsumori (2015) pointed out that, in the case of the Tsuchiyu hot springs, the community was rejuvenated as a result of a community revitalization program based on the sales of electricity resulting from binary power generation, and that the validity and usefulness of the program helped to deepen the understanding of renewable energy amongst citizens through trial programs.

In previous studies, there were comments to the effect that, following the earthquake, local-based renewable energy initiatives were implemented in Fukushima Prefecture and that these

have had a positive effect on the community. The authors also visited Fukushima Prefecture and observed that local electric power for the purpose of returning profits to the region had served to advance the construction of many power plants in the City of Fukushima, examples of which include Aizu Electric Power Company and Iitate Electric Power Company (Figures 4, 5). However, following the Great East Japan Earthquake, the harsh reality of the destruction wrought on the area is still evident and has not been swept aside by energy conversion efforts. Based on

Figure 4. A solar power plant owned by Aizu Electric Power Company (Photo taken January 16, 2017 by the authors)

Figure 5. An agricultural type of photovoltaic power station belonging to Iitate Electric in Iitate village (Photo taken January 17, 2017 by the authors)

the results of the lead author's field study, we seek to outline the complex social context included in the energy development of local communities.

For example, from the time of the disaster up until April 2017, Iitate village in Fukushima Prefecture was given the status of an area that was difficult to return to. In other words, while short stays during daylight hours were possible, as a rule, residents were not allowed to return to live in the village[18]. Moreover, given the amount of radioactivity measured in the village, even up until 2017 it remained difficult to practice agriculture. As a result, lands that had up until then been used for agriculture were converted to use for photovoltaic power stations[19]. However, due to consistent earthquake reconstruction and land acquisition by companies, large-scale photovoltaic power stations have come to fill the landscape of Iitate village. Operated by entities from outside the region, these large-scale photovoltaic power stations obscure the golden grasslands of the area with their shiny black facades. Employees of Iitate Electric spoke of how individuals returning to the village were often absolutely heartbroken. However, there were also cases where renewable energy has positively impacted residents. Efforts to establish agricultural types of photovoltaic power stations in cooperation with farmers have met with success, and this has provided them with a source of income. Depending on how it is introduced, renewable energy can also serve as a kind of tailwind, providing local residents with emotional support. Pursuant to its implementation, it is also important that energy development take into account the local landscape and desires of local residents. It is thought that, due to nuclear power, it is in these very areas still suffering from the disaster that people have embraced renewable energy, making the renewable energy business and its efforts so crucial to the region.

5.2. Other Regions

Nagano Prefecture and Takarazuka City are mentioned as other areas where 100% renewable energy policies have been established in Japan. It is in Nagano Prefecture where the most concrete and diverse renewable energy policies for Japanese municipalities are being developed. Utilizing its abundant hydroelectric power, Nagano Prefecture is on target to achieve 100% renewable energy in the electricity sector in the current fiscal year. Nagano Prefecture is also engaged in proactive efforts to attract industry to the area, with its sights set on stimulating local

[18] An exception to this rule was made, however, for users of a nursing home in Iitate village, who were permitted to stay in the facility. However, because of the high levels of radiation present, users of the nursing home could not leave the building. An employee at Iitate Electric Power Company told us that, given the health hazard, the government should not have allowed these individuals to remain in Iitate village. Investigations in the field have also revealed that, with respect to radioactivity and community living, there was a conflict between the observance of the right to life and practical solutions. With respect to this, a journalist who was accompanying the group wrote an article about this in French.

[19] There is a system to convert all the agricultural land for installation, to set up renewable energy facilities on agricultural land, and a system that involves generating electricity while continuing farming activities by setting up supports (farm-type power generation equipment) on farmland. When converting the entire farm plot, an application must be made for permission to convert the agricultural land, and proper care must be taken when doing the conversion.

economies through renewable energy. A bedroom community in Osaka Prefecture, Takarazuka City, has one of the highest population densities in Japan. However, Takarazuka City is a shining example of how 100% renewable energy policy objectives can be met even in such a residential area. Furthermore, Yakushima has already achieved 100% renewable energy. Registered as a World Natural Heritage site, Yakushima is an island in Kagoshima Prefecture. Making full use of its abundant water resources, most of the power on the island is supplied by hydroelectric power generation. At the same time, working in cooperation with Kagoshima Prefecture and Nissan Motor Company, Yakushima is actively promoting the spread of electric vehicles and providing information on energy conservation to the public for education purposes[20].

6. Future Prospects for Energy Policies in Japan

As described above, the importance of active target setting at the regional level in the international community is emphasized in this paper, and we have stated that the regionally led 100% renewable energy policies in the field of renewable energy are growing, even as they become more diversified. The municipalities of the various countries mentioned above continue to respect the historical background and local conditions of each area, while formulating 100% renewable energy targets by comprehensively reevaluating the entire energy system. Moreover, even in urban areas, it has been pointed out in the cases addressed in this paper that, by combining climate change measures, regional development, and urban planning, it is possible to set a goal of a 100% renewable energy policy. Moving forward, in implementing medium- and long-term plans on a regional basis, one can find cases where regions will seek to participate in diverse sectors and evaluate projects from different angles, as it is clear that importance is attached not only to setting targets in writing but also to working hand-in-hand with local citizens. It is thought that initiatives resulting from national, regional, and municipal operations will continue to increase, so we plan on looking at future trends in this area, as we continue our analyses.

In this paper, we have focused on the policies of local governments. However, movements to establish 100% renewable energy goals are not limited to regional initiatives; such initiatives have been observed in the private sector, as well. For example, overseas, 111 companies have set 100% renewable energy supply targets[21]. Major IT-related industries, especially, consume huge amounts of electricity, so they are particularly susceptible to criticism regarding measures to fight global warming. As such, by presenting their 100% renewable energy targets, they seek to improve corporate value, while considering the rising environmental awareness of consumers. Meanwhile, in Japan, Ricoh Co. Ltd. was the first Japanese company to establish a 100%

[20] Based on the lead author's 2013 survey results

[21] Companies that have established 100% renewable energy targets can be viewed at http://there100.org/companies. For example, such well-known companies as Google, Apple, Facebook, H & M, IKEA, and Adobe have published the target values for their 100% renewable energy procurement.

renewable energy target, which it did in 2017[22]. However, other business sectors have been slow to react. Some companies have begun to proactively evaluate energy conversion even though they have not established any 100% renewable energy targets[23]. We believe that the unique social situation in Japan is one reason so few companies have come out with 100% renewable energy targets. First of all, closed off, the Japanese electricity market is still developing. The power generation and retail electricity markets have already been opened up, but there are only a few urban areas where multiple operators present a full range of prices. This is particularly true of sparsely populated areas where factories and research facilities are located, and the choices of power producers are not growing; in these areas, companies may not be able to select 100% renewable energy. Moreover, consumer awareness is also thought to have an effect. In September 2017, at the same time as the Local Renewables Conference was held in Nagano Prefecture, a new initiative—Japan's 100% Renewable energy Initiative webpage—was also launched. With the aim of solving energy problems and implementing a sustainable energy society, it is expected that various stakeholders such as Japanese municipalities, citizens, and companies will provide information and hold discussions and meetings, in an effort to actively participate in this effort.

However, to increase the future introduction of renewable energy in Japan, the government needs to reinforce transmission lines and carry out a drastic review of storage battery/pumped storage power generation use (Yasuda 2017). In August 2017, the "Energy Roundtable Meeting" to discuss Japan's long-term basic plan of energy was launched, and roundtable deliberations are currently being conducted on a regular basis. This roundtable covers a diverse range of issues, including how to evaluate expected changes in the energy market due to the spread of new technologies and systems such as energy mix and renewable energy ratio target setting and electric vehicles (EV) (Agency for Natural Resources and Energy 2017). It has been pointed out that Japan, which has few energy resources and has relied heavily on imports of fossil fuels and other natural resources, must consider how future trends in the international community should be incorporated into its own policy decisions. In public opinion polls since 2011, nuclear power generation has been positioned as an important base load power source in Japan's current basic energy plan, although nuclear power has failed to garner consistent support (Agency for Natural Resources and Energy 2017).

Given the effects of the nuclear power accident that are still evident in Fukushima Prefecture and public opinion as dealt with in this paper, the inference is that the further development of renewable energy will become increasingly important. However, in Japan and particularly in the outlying islands, in the past, power grid connection problems have been recognized as a major obstacle when it comes to the introduction of renewable energy, effectively ceasing discussions

[22] Ricoh plans to supply all its electricity in the form of 100% renewable energy by 2050. It also plans to achieve at least 30% renewable energy by 2030.

[23] Panasonic received the Zayed Future Energy Prize in 2015, and its contributions in the areas of energy saving, renewable energy and sustainability are highly thought of internationally.

on measures to promote this form of energy. Meanwhile, from the regional examples presented in this paper, we can see that it is possible to reevaluate renewable energy self-sufficiency goals by combining resources and projects, creating many choices when it comes to energy self-sufficiency solutions. With respect to Japan's energy policy, it is anticipated that while complicated and diverse issues continue to be summarized, positive targets will be set for the introduction of renewable energy due to government initiatives. With the coordination of Japan's strategic energy development and the citizen/regional/company initiatives that this study has outlined, we hope to continue to carefully consider how Japan can contribute to the Paris Agreement and sustainable development goals by maintaining a presence in the research networks that it has created.

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